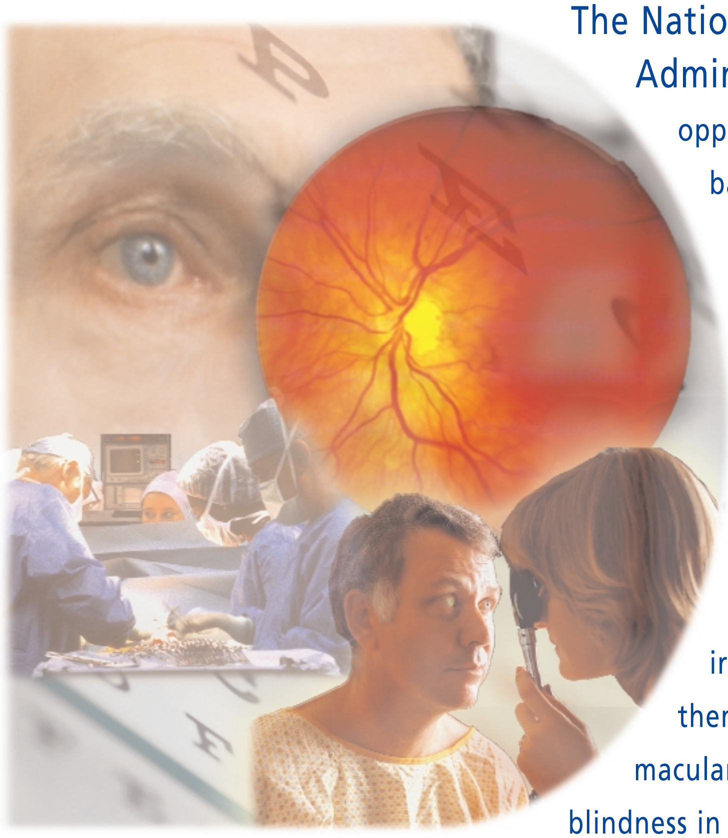
Carbon Nanotube Bucky Paper Scaffold

for Retinal Cell Transplantation



The National Aeronautics and Space Administration (NASA) is offering the opportunity to license and co-develop a technology based on carbon nanotube Bucky paper as a scaffold for transplanting cells into the retina. Developed at NASA's Ames Research Center, in conjunction with the Stanford University School of Medicine, the Bucky paper scaffold is produced using state-of-the-art nanotechnologies, and is characterized by a highly porous mesh structure. The scaffold is an ideal means for culturing retinal epithelial cells and iris pigment epithelial cells and transplanting them into the retina as a potential treatment for macular degeneration—the number one cause of blindness in the elderly.

Potential Applications

This invention was developed specifically for improving the vision of patients suffering from age-related macular degeneration. However, it has potential applications in culturing and supporting tissue for the treatment of other eye disorders. Potential applications include

- **Age-related Macular Degeneration –** More than 15 million Americans suffer from macular degenertion, the leading cause of vision loss in people over the age of 55.
- **Retinitis Pigmentosa (RP) –** May restore vision in patients with RP, an inherited disease of the retina that results in progressive loss of vision. Retinitis pigmentosa affects more than 100,000 people in the United States and more than 1.5 million people worldwide.
- **Traumatic Eye Damage –** May restore vision in patients with traumatically disrupted eye tissue by serving as a scaffold to re-establish the normal architecture of the eye.

Benefits

- Vision may be restored by tranplanting cells into the retina.
- The surface roughness and scaffold geometry are well suited for cellular attachment and for adsorption or covalent bonding of various growth factors.
- The pore size and overall pore volume of the scaffold are adjustable and may be optimized for the particular application.
- Adverse foreign-body or other immunological reactions are minimized because the mesh is composed entirely of carbon, which is biocompatible.
- The scaffold provides the right balance between flexibility and rigidity and is easily handled during eye surgery.

National Aeronautics and Space Administration

The Technology

Transplantation of retinal epithelial (RPE) and/or iris pigment epithelial (IPE) cells into the retina is under investigation as a potential treatment of age-related macular degeneration (AMD). Cells seeded without a support structure such as Bucky paper do not develop the spatial organization required for successful incorporation into the retina. Membranes currently being investigated as potential support structures for cellular transplantation into the retina-such as the anterior lens capsule or Descemet's membrane-are difficult to handle during surgery. These membranes tend to curl up, making precise placement difficult and presenting a major barrier to successful transplantation.

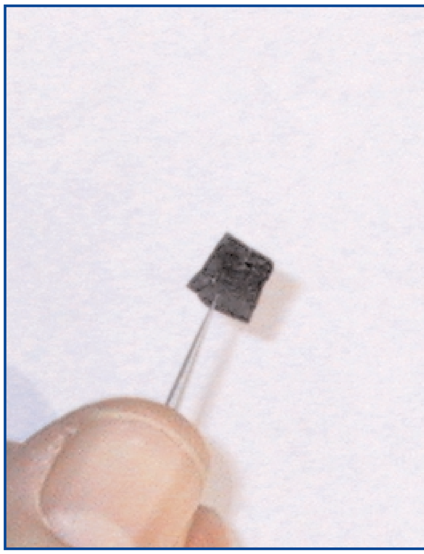


Figure 1: Bucky paper prior to implantation

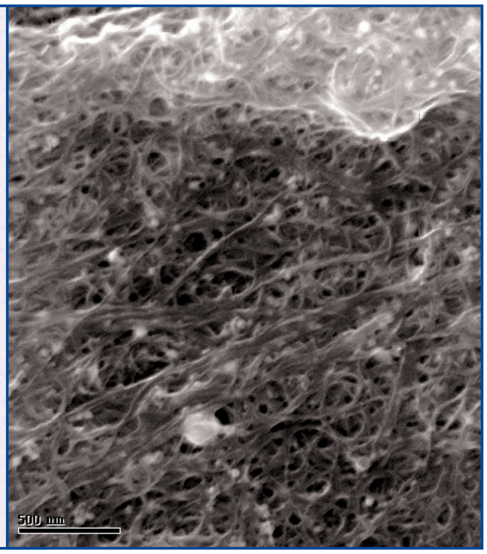


Figure 2: SEM image of Bucky paper, prepared at NASA Ames Research Center, showing the porous, meshwork structure.

The subject invention is composed of Bucky paper, an entangled mat of multiwalled carbon nanotubes. Shown in Figure 2, Bucky paper is a highly porous, mesh structure, with moderate rigidity and tremendous strength. The porosity of Bucky paper allows the free flow of nutrients and waste products through the transplant's thickness, providing a suitable environment for cell proliferation and incorporation. The scaffold arrangement solves the problem of spatial organization and overcomes mechanical barriers to transplantation presented by membranes.

Bucky paper scaffolds have been implanted into the subretinal space of rabbits. Although only short-term data (one week post implantation) have been obtained, all histology has shown favorable acceptance of the scaffold. Longer term *in vitro* and *in vivo* tests are underway.

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Dr. Loftus received his undergraduate education in Chemistry at Pomona College (Claremont, California) in 1981. He graduated from the Medical Scientist Training Program at Washington University in 1989, where he received an M.D. and a Ph.D. in Biophysics. Dr. Loftus completed a residency in internal medicine and a fellowship in hematology at Stanford University School of Medicine. Dr. Loftus' research interests include cellular and molecular biophysics, biochemistry, immunology, neurobiology, hematology, transplantation biology, cancer molecular genetics, tissue engineering and medical applications of nanotechnology. Dr. Loftus is involved in a wide range of basic science and technology development projects, including development of a biosensor for detection of cancer molecular signatures, development of liposome nanovesicles with engineered enzymes as biosensors, and ophthalmological applications of carbon nanotubes. Dr. Loftus joined NASA Ames Research Center in 2000, and holds a part-time faculty appointment at Stanford University School of Medicine.

Technology Commercialization Status

NASA Ames is currently seeking U.S. companies interested in further development and commercialization of this technology. A patent application has been submitted and opportunities for licensing and development partnerships exist.

For More Information

For more information about this technology or to obtain a license application, contact

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